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ABSTRACT

This study explores the use of cues and their possible interaction with learner ability in concept formation under inductive instructional methods. Ninth- and tenth-grade biology students (N=61) were administered a verbal aptitude test, then randomly assigned to one of two inductively presented slide-tape sequences on monocots and dicots. In the cueing treatment, slides were presented containing written cues and feedback statements: the second treatment consisted only of slides with feedback statements. Multiple regression analysis was used to test for main effects and aptitude treatment interactions. Findings of this study include the implication that differential assignment to alternative treatments is appropriate for maximizing learning outcomes, particularly for low ability learners. (CS)

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Differential Response to Cueing and Feedback in The Acquisition of An Inductively Presented Biologic Concept[1]

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Inductive instructional systems have many advocates in science education because such systems engender inquiry and investigative characteristics valued as outcomes of instruction in this area. (Shulman, L. S. and Tamir, P. 1973). However, despite the strong endorsements of inductive instruction frequently encountered, there is little substantial knowledge regarding what advantages it offers and under what conditions such advantages accrue (Shulman and Keislar, 1966). Research in this area has frequently been inconclusive and of little practical utility because of: 1) a lack of operational definitions that permit replication and generalization; 2) a lack of instructional objectives that correspond with school learning tasks and settings; 3) a failure to specify and/or manage systematically the exposure time of subjects to examples and the types and frequencies of cueing or feedback events experienced by subjects (Clark, 1971, Cronbach, 1966). However, in his review or research on discovery learning, Cronbach (1966) concluded:

> When the research is in it will tell us, I suspect, that inductive teaching has value in nearly every area of the curriculum and also that its function is specialized and limited. The task of research is to define that proper place and function....I propose that we search for limited generalizations of the following form: With subject matter of this nature, inductive experience of this type, in this amount, produces this pattern of responses, in pupils at this level of development.

When inductive systems require a learner to search among examples and strive to identify regularities or rules regarding the examples (Koran, Koran and Freeman, 1976), many overt and covert responses are made, both appropriate and inappropriate. One outcome observed under

these conditions is that this search and selection process tends to result in an increased probability of errors which may result in increased habit strength for incorrect responses (Glaser, 1966), especially for low ability students for whom the initial probability of errors is relatively high (Snow, 1974). Therefore, it is not surprising to note that low ability students have tended to fare particularly poorly under inductive methods. (Cronbach and Snow, 1977). Indeed, Koran and Koran (1976) and Wright (1977) found that in general, students receiving inductive instruction often scored no better than chance on criterion measures used and deductively taught students significantly exceeded those taught inductively. However, since inductive instructional experiences do call upon skills we wish to develop in all science students, the development of inductive treatments which could accomplish this objective while reducing errorful learning would seem to be of high theoretical and practical significance.

One possible way of reducing response errors during inductive instruction is to increase attention directing and controlling properties through the use of cues within the instructional sequence. Early concept formation research has shown that the use of cues has a generally positive effect on subsequent recall (Tulving and Pearlstone, 1966), functioning to focus the learners attention on the relevant aspects of the stimulus situation. Cues are also helpful in the identification of concepts because they function to partition stimulus sets into subsets which correspond to the response system

which denotes the solution (Osler and Draxl, 1977). Thus it is conceivable that the use of cues may improve the general effectiveness of concept formation under inductive instructional methods. Moreover, if lower ability students are weak primarily in attentional and discrimination skills, as suggested by the work of Zeaman and House (1967), the use of specific cues would be expected to primarily benefit low ability learners through their attention directing and controlling function. There is both theoretical and empirical support for the position that learning effectiveness is a function of the interaction of instructional treatments and learner characteristics (Cronbach and Snow, 1977). Accordingly, the incorporation of learner characteristics into learning research and theory is important for determining the individual parameters within which more general principles of learning might be expected to be applicable. Thus, the purpose of this study was to explore the use of cues and their possible interaction with learner ability in concept formation under inductive instructional methods.

Method, Subjects and Procedures

The experimental sample consisted of sixty-one ninth and tenth grade science students in a rural Florida high school. Students were given a test of Verbal Comprehension selected from the French Kit of Reference Tests for Cognitive Factors and then randomly assigned to one of two 35 mm slide tape sequences on monocots which were inductively presented. In the cueing treatment, a sequence of 24 slides provided students with a specific cue on the first slide of each sequence of 8 slides. Each cue

focused on a critical characteristic of angiosperms: veination type, fibrovascular bundle organization, or petal and sepal number. Feedback was provided on each slide confirming whether or not the plant was a monocot (a small "yes" or "no" appeared at the bottom of each slide). Each cue directed student attention to either the leaf veination, petal number or fibrovascular bundle organization. The feedback treatment omitted the cues, and provided only the feedback (yes or no appearing at the bottom of the slide). The students' task in each case was to infer the defining characteristics of a monocot from the eight examples given.

All oral instructions were given on an audio tape synchronized with the 35 mm carousel slide projector. Both treatments were of equal duration and were administered to treatment groups in two adjoining rooms during two 55 minute class periods. The series of 35 mm plant slides were presented in the following sequence: 1) introduction to vascular plant morphology; 2) instructions for pretest and posttest (1 slide); 3) pretest (30 slides); 4) description of instructional procedures (1 slide); 5) instructions for use of examples (1 slide); 6) positive and negative examples (24 slides); 7) posttest 30 slides. Both treatments were of equal duration with exposure time to examples managed by a timer on the carousel slide projector. The entire study took place in a regular classroom over one days time. The treatments were designed in the following way:

Inductive: Cueing: Subjects in this treatment were exposed to three groups of 24 slides depicting vascular plants. The slides were organized

so that each group of eight provided four positive and four negative examples of plants highlighting one of three defining characteristics of monocots: veination, petal number, or fibrovascular bundle organization. Positive and negative examples were randomly ordered and each had a "yes" or "no" in the corner of the slide indicating that yes it was a monocot or no it was not. The specific cues preceeding each group of eight slides said one of the following: pay attention to the appearance of the leaf veins, pay attention to the petal number, or pay attention to the fibrovascular bundle organization.

Inductive: Feedback: The same format was used in this treatment but the specific cues preceding each group of slides were absent. Hence, subjects went through the set induction materials and saw the same randomly ordered sets of slides. Each slide had the "yes" or "no" in the lower right hand corner indicating that it was not a monocot. Students had to infer from the slides presented what constituted a monocot and utilize this information during the posttest. (A more detailed description of similar experimental logistics can be found in Koran, J. J. Jr., Koran, M. L., Freeman, P. 1976.)

The verbal aptitude test (Vocabulary 1) was selected from the French Kit of Reference Test for Cognitive Factors (French, Ekstrom, Price, 1963) as an index of general ability. The criterion measure was a previously unobserved thirty slide sequence of monocots and dicots which students were shown prior to and after the treatments. A Kr21 reliability estimate yielded .82.

Results

Multiple regression analysis was used to test for both main effects and aptitude-treatment interactions (Cronbach, L. and Snow, R., 1977). In this model, .49 percent of the total variance was accounted for by treatment type and interaction. The means and standard deviations for the two treatment groups appear in Table 1.

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Insert Table 1 Approximately Here

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It can be seen from this table that performance on the pretest for both groups approximated chance, indicating that the subjects were not familiar with the concept of "monocot" prior to instruction. Posttest scores were significantly different ($F=21.31$; $p<.01$) with subjects in the specific cueing plus feedback treatment significantly exceeding those in the non-cued group.

Analysis of aptitude-treatment interaction produced a significant (disordinal interaction) in which verbal comprehension scores interacted significantly with the two inductive treatments ($F=4.54$ $p<.05$). While the cued treatment was most effective overall, low ability students profited most from the cued treatment, while those students at the extreme upper end of the ability distribution performed best in the non-cued treatment.

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Insert Table 2 and Figure 1 Approximately Here

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DISCUSSION

It will be recalled that the major purpose of this study was to examine the use of cues in concept learning under inductive instruction and their possible interaction with learner ability. It was anticipated that the use of specific cues would enhance the general effectiveness of concept learning under inductive instruction, and that the advantages of cueing would vary according to learner ability to discriminate and attend to the relevant aspects of the stimulus display during instruction. Accordingly, cueing was expected to primarily benefit low ability students. The pattern of results obtained supported these expectations. While the cueing treatment was most effective overall in prompting concept learning from inductive instruction, low ability students benefited most from their use. Thus low ability students were able to use the cues to help them discriminate task relevant information from erroneous or irrelevant information, thereby learning more effectively from inductive instruction. Moreover, it is possible that the cues served not only to direct and control attention, but also to facilitate more efficient strategies for coding and processing information (Landau and Hagen, 1974).

These results are in accord with the results of previous aptitude-treatment interaction research in which it has been found that treatments which appear to force attention to and differentiation of stimulus detail appear to primarily benefit subjects of low general ability, while high ability students have been found to perform better in treatments which leave much of the burden of structuring and organizing

stimuli to the learner (Cronbach, and Snow, 1977). Accordingly, aptitude-treatment interaction can again be seen as arising from a compensatory-conciliatory process in which a treatment may either compensate for a particular learner deficiency or capitalize on another well developed characteristic of the learner (Koran, 1974).

The reported interaction was a disordinal interaction in that the regression slopes intersected within the range of the aptitude being considered (Cronbach and Snow, 1977). Such findings imply, in general, that differential assignment to alternative treatments is appropriate for maximizing learning outcomes. The point at which the regression slopes intersected was sufficiently high though, so that few students actually scored beyond the point at which the non-cued treatment would be predicted to be more effective than the cued treatment. Such an interaction generally implies a stronger disordinal interaction given a more extended range of student aptitudes, or further manipulation of an experimental variable, such as the cueing procedure utilized in this study (Cronbach, and Snow, 1977). Additional reflection would undoubtedly suggest a variety of ways in which the aptitude measures, instructional materials and criterion measures might be varied to maximize the results obtained. Further experimentation along this line may help provide more effective ways for all students to achieve those outcomes in science education valued from inductive instruction, as well as decision rules for the assignment of students to alternative treatments designed to reach these same terminal objectives.

Table 1

Means and Standard Deviations for Treatment Groups

Treatment	Pretest Mean	Pretest S.D.	Posttest Mean	Posttest S.D.
Inductive: Cueing N=31	15.17	2.41	25.45	3.10
Inductive: Feedback N=30	15.34	2.55	19.23	4.18

Table 2

Regression Analysis: Aptitude Treatment Interaction

Treatment Group	Written Criterion Measures	
	A	B
Inductive: Cueing	25.2	.015
Inductive: Feedback	14.99	.31

Note: a and b are of the form $\hat{y}=a+bx$

$f=4.54$; $p<.05$

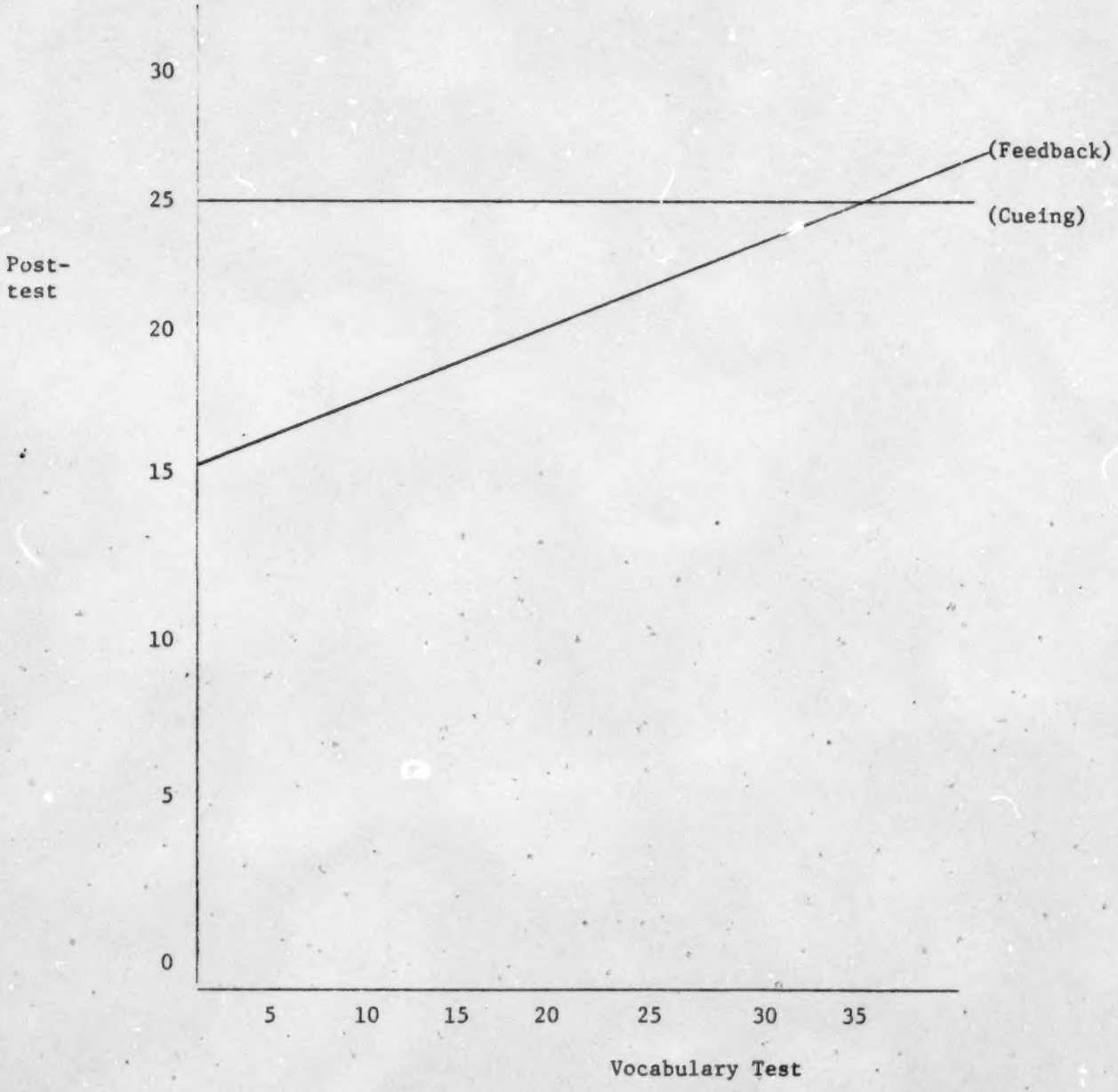

Figure 1 - Interacting of vocabulary scores and criterion scores.

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